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THE TEACHING OF MATHEMATICS TO STUDENTS OF ENGINEERING[1]

FROM THE STANDPOINT OF THE PRACTISING ENGINEER

I am honored by being asked to say a few words to you about the results of my experience as to the needs of the teaching of mathematics to students of engineering from the point of view of a practical engineer. I have had the good fortune of receiving quite a thorough mathematical training in the École des Ponts et Chaussèes of France, and I have also had the good fortune of developing into a fairly practical engineer; my remarks will therefore be backed by actual experience.

Mathematics is to an engineer what anatomy is to a surgeon, what chemistry is to an apothecary, what the drill is to an army officer. It is indispensable. I think we all agree on this point.

There is a considerable agitation at this time in France and Germany, especially the former, favoring the limitation of the

[1] What is Needed in the Teaching of Mathematics to Students of Engineering? (*a*) Range of Subjects; (*b*) Extent in the Various Subjects; (*c*) Methods of Presentation; (*d*) Chief Aims. A series of prepared discussions following the formal presentation of the subject by Professor Edgar J. Townsend, Professor Alexander Ziwet, Mr. Charles F. Scott and President Robert S. Woodward. (See SCIENCE, July 17, 1908, pp. 69–79; July 24, 1908, pp. 109–113, and July 31, 1908, pp. 129–138.) Presented before Sections D and A of the American Association for the Advancement of Science and the Chicago Section of the American Mathematical Society, at the Chicago meeting, December 31, 1907.

present mathematical program of the engineering schools on the ground that it is unnecessarily extensive. From personal observation, I can say that the program there covers a considerably wider range than in the average American college. In the first place, a student entering an engineering college on the European continent must already know the analytical geometry, the descriptive geometry, the rudiments of differential and integral calculus, none of which are taught here until the student enters college. The average length of a college engineering course abroad is four years, one of the exceptions being the École Centrale, of Paris, France, where the course is only three years, but where the entering examinations are of a comparatively high standard and the students must be above the average in ability and application in order to hold their own during the college course. It is obvious, therefore, that in American colleges, time is spent on pure mathematics which could be devoted to practical study. I believe the time will come when only applied mathematics will be taught in colleges, and all necessary abstract mathematics will form a part of the conditions for entering.

As time goes on, every profession tends more and more towards specialization. This tendency is quite marked in the engineering profession. It would take too long to enumerate all of these special branches of engineering, but nearly every branch demands a somewhat different mathematical training. The time may come when this specialization will extend over the study of abstract mathematics, differing with each student according to the branch of engineering he intends to follow. For instance, a railway engineer who may aspire to become a railroad official requires less knowledge of calculus than an electrical or a bridge engineer; on the other hand, he requires a greater knowledge of geology than the electrical engineer, and a greater knowledge of common law than the bridge engineer. As my remarks are merely intended to furnish topics for discussion, I will put the following question: In view of the fact of the steadily growing scope of special education will it be desirable and possible to specialize mathematical courses in colleges and adapt them to each branch of engineering? This, as I understand, is done at present only to a small extent in applied mathematics.

Bridge engineering, of which I have made a specialty, requires probably as high a mathematical training as any other branch of the profession, and yet, I find that part of the higher mathematics which I have studied in college, apart from the drilling features of such studies, has been entirely useless; for instance, the theory of differential equations. The time I spent on it, though considerable, was not sufficient to make me understand it thoroughly, and would have been better employed in the study of the methods of least work, for instance, which no bridge engineer should neglect to study.

On perusing the elementary books used in high schools, I have been often struck with the dry, uninteresting manner in which the various subjects are being treated. The examples are mostly abstract, very few practical problems to work out. Unless the student is very intelligent, his mind retains nothing beyond a chaos of formulæ hard to remember and a few mechanical means of solving abstract problems. He is incapable of applying an equation to a practical problem. The methods of presentation should, therefore, be such that the student knows the why and wherefore of each operation—in other words, that he learns to *think mathematically*. This training in mathematical thinking should

also be the chief aim: one does not know a foreign language unless one is able to think in that language; one does not know mathematics unless one is able to think mathematically. It is not necessary for that to go up into the highest mathematics, but it is necessary to be thoroughly drilled in elementary principles of each subject. These elementary principles should become a second nature to the student, just as a language becomes a second nature when it is thoroughly acquired. Problems arise every day in the practise of an engineer, which a mathematical mind can solve without going into calculations, such principles as those of maxima and minima, those of least work, of cumulative effect of forces and others are invaluable in assisting to arrive at a logical solution of many problems without the use of a scrap of paper; but in order that they may be applied, one has to be able to think mathematically. With a proper foundation, the engineer's mind becomes so trained that he applies those fundamental principles unconsciously; they direct his line of thought automatically, so to speak. How to secure such a foundation in a student must be left to those who make a life-study of teaching.

Ralph Modjeski

Chicago, Ill.

The methods of teaching mathematics to engineering students in vogue twenty years or more ago, while often sufficiently strenuous, were invariably far from satisfactory, in that they failed to show the application of the subjects to engineering practise and to explain that mathematical quantities represent something real and tangible, not merely abstractions. Possibly methods have changed of late years; but nothing that the writer has seen or heard indicates to him that any fundamental improvement has been effected. Most people continue to believe that mathematical subjects are taught mainly for the purpose of training the mind, and that the manipulations involved in this branch of science are simply mental gymnastics. Moreover, even among engineers and professors, only a few recognize adequately the great importance of mathematics in engineering and that it is something real and substantial instead of fictitious and imaginary. It is true that higher powers than the third are not conceivable entities; but the mathematician recognizes them as temporary multiples for future reduction to entities.

The engineering student in his pure-mathematical classes is not taught what equations really mean, nor what are their denominations or those of their component parts. All that he learns is how to juggle with quantities in order to produce certain results. It is left to the professor of rational mechanics to teach engineering students the reality of mathematics; and too often he fails to do so, sometimes, perhaps, because his own conception thereof is rather vague.

Concerning the teaching of pure mathematics by the professor of rational mechanics the writer speaks from personal experience; for more than a quarter of a century ago he taught that branch of engineering education in one of America's leading technical schools. Notwithstanding the fact that the courses in pure mathematics then given there were rigid and even severe, the students, as a rule, had no idea of how properly to apply the knowledge they had accumulated; nor did they know what the mathematical terms employed really meant. It was necessary for the writer not only to teach his own branch, but also to supplement the students' knowledge of pure mathematics by explaining such things as limits, differential coeffi-

cients, total and partial differentials, and maxima and minima.

Throughout the entire course in rational mechanics the writer either demanded from the students or gave them demonstrations of all difficult or important formulæ; and the students in explaining their blackboard work were repeatedly asked to state the denominations, not only of the equations as a whole, but also of their factors and component parts. The answers to such questions evidenced clearly whether the student had a true conception of the mathematical work he was doing, or whether he had merely memorized certain manipulations of quantities.

It was the writer's custom also to supplement as much as possible all analytical work by graphical demonstrations; and if he were to resume the teaching of mechanics, he would adhere to this method.

In teaching technical mechanics the writer followed only to a certain extent the manner of instruction just described; for by the time his students had reached the technical studies, they were so well drilled and weeded out that constant quizzing on fundamentals was no longer necessary; nevertheless the question, "what is the denomination of that equation or of that quantity," was one that was very likely to be asked any student who gave his demonstrations haltingly or who evidenced at all a lack of conception of the principles involved.

In the writer's opinion, the manner of teaching pure mathematics to engineering students should differ materially from that usually employed in academic courses; for while in the latter case it suffices if the instructors be good mathematicians, in the former they should also be engineers, and should have taught, or at least should have studied specially, both rational and technical mechanics.

Some institutions still adhere to the antiquated custom of teaching pure mathematics by lectures. This method has always appeared to the writer to be perfectly absurd; for the primary benefit to be obtained from the study of mathematics is mental training; and the student can get this only by severe effort, and not by having another man's mind do the reasoning for him. Midnight oil and the damp towel are for most students necessary accessories to the courses in pure mathematics.

The writer believes that the only legitimate lectures in pure-mathematical courses for engineering students are as follows:

First: A short opening lecture to outline the work that is to be covered in the course and to explain how best to study the subject.

Second: Frequent informal talks to indicate the application of the mathematics studied to engineering practise, to explain clearly the meaning of all equations, factors and terms, and to show the true *raison d'être* of all that is being done.

Third: A concluding lecture in the nature of a résumé to call attention to what has been accomplished during the entire course and to the importance thereof.

Fourth: Personal and forcible lectures to lazy students so as to give them clearly to understand that they must either study harder or drop out of the class.

All mathematical work done by engineering students should be so thorough and complete that the subject shall be almost as much at command as the English language or the four simple rules of arithmetic. Only such thorough knowledge will enable the engineer to use mathematics readily as a tool, rather than as a final resource to be employed solely in extreme need.

Analytical geometry should be taught graphically as well as analytically in order that the student shall comprehend it fully and shall realize that the work is real and tangible and that the equations represent

lines, surfaces, and volumes, and are not the results of mere gymnastics. A knowledge of the graphics of analytical geometry is especially valuable in mechanical work, in the investigation of earth pressures, in suspension, bridge work, and in many other lines of engineering.

The proper conception of the meaning of the calculus is rarely carried away by the student. He knows the rules and can perform the operations, but their significance is beyond him; consequently he does haltingly and bunglingly the original work which facility in the use of the calculus should enable him to perform easily and well. This state of affairs is a crying evil which should be corrected in all schools that aim to give first class engineering courses.

Descriptive geometry is of very large value in the preparation of drawings; but, in addition, a thorough knowledge of it greatly aids in the conception of an object in space, and, consequently, is of large assistance in the evolution of original designs. A knowledge of it prior to the study of the courses in pure mathematics assists materially in the conception of what the latter really mean; consequently descriptive geometry should be one of the earliest courses in an engineering curriculum.

A sound knowledge of mechanics, the foundation of engineering, is impossible without a thorough understanding of mathematics. It is true that mechanics may be learned by rote or by so-called common-sense methods; but the "rule of thumb" or "pocket-book" engineer never rises to noticeable heights. Such an engineer almost invariably fails at the critical moment, when a decision must be supported by fundamental principles. It is true that the actual use of analytical geometry, calculus, least squares, or even higher algebra and spherical trigonometry, is rare in the practise of most engineers; but an engineer's grasp of technical work depends upon his knowledge of these subjects; and it is generally conceded that a heavy structure can not be continuously supported on a weak foundation.

Mathematics higher than the calculus is of small value to the engineer, except possibly as a training for the mind; but the writer is of the opinion that any such further study of mathematics is a detriment rather than a help, in that it tends to a desire to reduce all work to mathematical calculation and thus to weaken the judgment. In other words, excess of mathematical development sometimes produces an unpractical engineer.

Most graduate engineers immediately after leaving their *alma mater* drop forever the study of mathematics, both pure and applied, except in so far as they are forced to use them by their professional work. No greater mistake than this can be made, for it takes very few years of nonuse of these subjects to cause one to forget them utterly. Every young engineer should make it a point to devote a certain portion of his time to the reviewing of the mathematical studies of his technical course so as never to become rusty in them; and the writer believes that it is the duty of every professor of mathematics and mechanics to impress this fact continually upon the minds of his students, even up to the very day of their graduation.

J. A. L. Waddell

Kansas City, Mo.

FROM THE STANDPOINT OF THE PROFESSOR OF ENGINEERING

When I come to think of what the Mathematical Society has brought upon itself, I fear that it may feel something like the football when it is kicked back and forth upon the field. On the one hand we have the trade-school element demanding more knowledge of rules and, on the other, the

engineer demanding more knowledge of principles. No fair discussion of this subject can be had without considering for a moment the conditions and definition of engineering itself. The most common definition was promulgated more than half a century ago by Thomas Tredgold, to the effect that civil engineering, which was the only branch of engineering then known, so the definition may be considered as being general, that "civil engineering is the art of directing the great sources of power in nature to the use and convenience of man." I should say that "civil engineering today is the art *and science* of directing the great sources of power in nature to the use and convenience of man," and from that standpoint I am willing to discuss the question as to how much and how far mathematical instruction should enter.

If engineering is merely an art, then mathematics as a science has no place in the training of the engineer, but if engineering is a science, then mathematics has a place. Engineering stands to-day in the act of rising to the status of a science, but is still hampered by the tradesman. On the one hand, we have the demand that the student's training be such as primarily to make him useful to some one to-morrow; and, on the other side, that it make him useful to the world perhaps ten years hence. The two requirements are inconsistent and do not belong together. One is that of the trade school, and many should not go farther than that because they have not the mental capacity, and the other is the demand of the profession into which a smaller number are qualified to enter. The trade school has caused most of the trouble with the teaching of mathematics because those who are products of the trade school have no use for mathematics as a science. The complaint about the teaching of mathematics does not come from engineers; they are ready to use mathematics as a science. In civil engineering it is fortunate that the profession has developed along lines laid down by Rankine rather than by Trautwine. Both have had their use, but one of them produced the scientist and the other produced the tradesman.

It is maintained in the institution which I have the honor to represent that they who would teach engineering must practise it, and by analogy we might say that those who teach mathematics to engineers should themselves be engineers. It seems to me that a time may come when such a condition will be desirable, but let me say now that there are few engineers to-day who have had sufficient training in mathematics to teach it themselves, much less to tell mathematicians how it should be taught. We can perhaps judge of the deficiency of the student who comes to us, but my feeling is that the remedy is not a question of *what,* but of *how.* Men in my institution are sending us students well prepared in mathematics. Others do not seem to be so fortunate. Both are teaching the same subjects. We have to realize that the student himself is a factor in this question. Some students become mathematicians under any *one;* others would not under *any* one. To be taught mathematics properly, the point at which engineering minds must begin, is a long way back. I am inclined to think they must begin some generations before birth. The mathematics of grammar schools needs overhauling more than the mathematics of any other part of our educational system, and probably the mathematics of high schools stands next. The essential thing that we ask of mathematics is that it should develop the quantitative reasoning power, and the student must be able to think mathematically. If he has not acquired that, then he should drop out of engineering and take up a trade. It was mentioned by a previous speaker that a relatively small percentage

of the graduates from a certain engineering school were engaged in occupations in which mathematics was of importance. From a somewhat intimate acquaintance with the graduates of that institution, I may add that a much less proportion had sufficient mathematical training to take positions in which mathematics was an important requirement. Until recently, that college has stood for hardly more than a highly developed trade school, and it is not fair to cite its statistics as showing conditions of *engineering schools*. The director of that institution stated many years ago that he did not consider descriptive geometry necessary for mechanical engineers, and his students, having had their course in machine design in the junior year were frequently found taking their only course of descriptive geometry when seniors.

The question has been raised as to the increase of mathematics for entrance to engineering schools. My view of that is that it would not be wise to raise the requirements at this time. Cornell has, it is true, increased the requirements, but at the sacrifice of both physics and chemistry, and to my mind it is best that physics and chemistry be taught at the age of high school students, rather than analytics and trigonometry. If you can not do both it is better that the young mind have impressed upon it some physical science rather than encounter the more abstract demands of mathematics. In the training of students in mathematics I would wipe out formulæ. We want principles. There is generally taught too much of the formula, as that is what the trade school has demanded. Some have objected to the statement that mathematics should be a tool. To my mind it is certainly an instrument. It is one of the things that the engineer must use, and in order that he may use it, he must be sufficiently familiar with it, so that it will respond to his use when he desires it. The question of election in mathematics has been suggested. I am certainly favorable to elections in that subject, but I question the advisability of such opportunity in any subject for the ordinary student, before the fourth year. My own observation leads me to conclude that very few students are able to elect intelligently before that time. The remarks relative to the employment of inexperienced instructors instead of competent professors show a fault to lie with the heads of the various departments themselves. If they are willing to accept, for the purpose of instructing students, the men who have been unable to find positions elsewhere, and employ only such as will work for seven to nine hundred dollars per year, the unsatisfactory results are their own fault. The responsible parties, the trustees and regents of educational institutions, will furnish what is shown to be necessary. If it is necessary that you have better men, then say so and get them, but if you are satisfied with what you now have, then you can expect to see decorative cornices and stained glass windows, rather than intellect and culture, the characteristics of our universities.

Gardner S. Williams
University of Michigan

It may save time to state briefly at the beginning my thought on what is needed in the teaching of mathematics to engineering students. It seems to me that, outside of the general cultural and developmental purpose of the study of mathematics, the instruction of engineering students may be discussed under three different phases, which for want of better terms may be named: (1) theory, (2) practise, (3) philosophy; that successful teaching of mathematics to engineering students depends upon giving the right

relative proportion or emphasis to these three phases of instruction; that the content of the instruction, within the limits of present usage in engineering schools, is of minor importance; that thoroughness is essential, and that it is better to cut down the extent of the matter gone over if thereby a more thorough grasp of the subject is secured; and that the instructor must always keep in mind that he is training an average boy of average preparation with a view to using mathematical principles and methods of attack and mathematical operations and conceptions in the mastery of his engineering studies and in the treatment of the varied problems which will arise in his later engineering experience.

The great mass of our engineering students, like the great mass of our engineers, are not mathematical geniuses. In the discussion of the subject we must keep ever in mind that the average engineering student is not of strong mathematical bent. Many of those with only mediocre mathematical ability make successful engineers, and the student of strong mathematical turn may lack in some direction or may have a disproportionate measure of the importance of his analytical powers and drop behind his less mathematical classmate. I want to make a plea for the average student, the boy whose analytical powers have to be encouraged and developed. The methods of presentation must be made elastic enough to include this great class of students, or we shall fail to do our duty as teachers.

I have mentioned three phases in the presentation of mathematical subjects. These may be considered in order. It must be understood that these phases are not mutually exclusive.

1. *Theory.*—Analysis, demonstration and the general derivation and presentation of mathematical principles. The derivation and exposition of mathematical principles and operations and the appreciation of mathematical concepts are universally accepted as important elements in the education of an engineer. The use of mathematical forms of attack, the training in processes of reasoning, the formation of logical habits of thought, are hardly secondary in importance. And yet much less emphasis is placed on formal demonstration and reasoning than formerly—frequently this element is overlooked or treated in a slipshod way. The student comes to feel that he is after facts and that the derivation and proof of principles involves useless effort—he is willing to accept their authenticity. It may be that years ago our instructional methods carried formal processes to an extreme and that as a result mathematical work became meaningless lingo or memorized facts to many students. This does not furnish argument for the abandonment of training in formal reasoning. For the young mind, practise in analysis, in formal demonstration is illuminating and developing. Even the repetitive forms of analysis in the old-time mental arithmetic had great mathematical educational value. The speaker feels that in the effort to avoid barren formalism the pendulum has swung too far the other way, and that both in high school and in technical school, and in the applied engineering subjects as well, the training in analytical methods and formal processes is weak. He believes that good results would follow putting greater emphasis on this phase of instruction than now seems to be the trend.

2. *Practise.*—The use and applicability of mathematical principles and processes in the solution of problems, drill on these principles, and the acquisition of facility in their use. To the average student the working of examples is illuminating. Without it the concept is but vaguely comprehended, the derivation only faintly

understood, the process may seem merely verbal legerdemain. Properly used, this phase of mathematical instruction is of great advantage to the student of average mathematical ability. It opens up the view; it clears away uncertainties; it fixes principles and concepts; it gives life to the subject. The problems used should be within the field of the students' experience and comprehension and may well bear some relation to his future work, both in the engineering class-room and beyond. And the second part of this heading is not less important. Mathematics is a tool for the engineering student, and he must acquire facility in its use. This does not mean that the instructor should attempt to make him a finished calculator or an expert workman—time is too short—but mathematical principles and processes must be more to the student than a vague something which he recognizes when his attention is directed thereto. Instead, he must have a mastery of at least the fundamentals and he must be able to use such principles and processes in his later studies without having to divert his attention and energy too much from the engineering features involved. To acquire this facility requires drill and repetition, and this drill must constitute a part of the mathematical training of the engineering student. The multiplication table had to be learned, and many other important things have to be acquired in the same way.

But it seems that this important side of instruction may be abused. The student who thinks that to accept facts and work problems is sufficient and the instructor who thinks that illustrations and practise work alone constitute mathematical training or that mere laboratory methods suffice are greatly mistaken. The mere substitution in formulas is only rule-of-thumb work, so much decried in engineering; and the mechanic who knows how to use tools, and no more, is not an engineer. There must be a direct connection with the theory and the philosophy of the subject to make the practise side serve its proper purpose. In teaching mathematics years ago, expressions of approval came to me because I was so "practical," but the underlying purpose of the practical part was not always understood, though this lack of understanding did not affect the results of the method. Inside the "sugar coating" there should always be a principle to fix, a concept to illumine, a process to exemplify, a derivation to expound. There seems to be a tendency among some to overdo this side of the work to the detriment of the first side. While the practise feature is a valuable auxiliary in mathematical instruction, it should never be the leading motive. Student and instructor alike should recognize this.

3. *Philosophy of the Subject.*—The basis on which the science rests, the underlying meaning of the mathematical processes used, a philosophical study of the method of treatment and of the concepts used, their connection with related things. This is difficult to discuss in a general way, and of course this phase is intimately connected with the first and second. To my mind this phase should not be neglected. It must be apportioned according to the ability of the student. An understanding of the philosophy of the subject will widen his field of view and lessen the chances of error. The better grasp of the meaning will be advantageous. Its presentation involves difficulties, and text-books generally disregard it. It must not be overemphasized, as is illustrated by the treatment in a recent text-book in applied mathematics, where it is used largely to the exclusion of analysis and demonstration.

Effective methods in mathematical subjects involve, then, the skillful selection in proper proportion from these three phases,

and the best teacher will make for himself the best selection. The derivation and elucidation of mathematical principles, facility in their use and application, and an understanding of the basis on which principles and methods rest are all essential. A good text-book—one properly proportioned—aids greatly in the work of instruction. However, it is the teacher on whom reliance is placed in the end, and for the student of average mathematical ability the teacher's influence constitutes a large element. It is highly advantageous for the teacher to have a fair knowledge of the applications of mathematics which the student will make in later work and to have sympathy and interest in such work. Let us also emphasize the importance of having the best of teachers for mathematical instruction.

Let me add to this that it is my belief, growing stronger after many years of observation, that the average engineering student gets relatively little from lectures on mathematical subjects; that many instructors talk too much themselves; that the student must have the opportunity to express himself and must be required to use the mathematical language and to try his own skill, and this in other than formal quizzes; and that recitation and drill work are essential factors in giving training to this average student.

Little can be said in the time at my disposal on the ground which should be covered in mathematical instruction. Two classes of matter are studied: (1) fundamental principles forming the skeleton of the work, and (2) the more complicated topics, involving further detail and insight. There will be little difference of opinion on the first class. There will be more on the second. I have found in the teaching of mechanics and of various engineering subjects that certain topics and methods not ordinarily given in mathematical instruction may advantageously be used in the presentation of the work. The teacher of thermo-dynamics or of electro-dynamics has other topics to suggest, and still other topics will come from other sources. Not all of these may be allowed. In fact, it makes little difference what particular topics are included so long as the student has thorough training in some of the more complex work. The difficulty of giving instruction in complex work lies not so much in the time required, as in the obstacle that the concepts lie beyond the student's experience and that he is not ready to comprehend their meaning. If he had the opportunity to study these topics after he has reached the subject in which they are to be used, or if he could go back over a part of mathematics after his study has taken him into their field of application, as indeed his instructor has done for himself, the result would be more satisfactory. All these limitations must be considered in choosing the ground to be covered in mathematical instruction.

Arthur N. Talbot

University of Illinois

GRADUATE SCHOOL OF HOME ECONOMICS

The Graduate School of Home Economics held its second session at Cornell University, July 13–24. Representatives were present from eleven states and Canada. It is the purpose of this school to consider some of the results of the latest investigations in science, economics and art with their applications to work in home economics; the program, therefore, covered a wide range of subjects.

Practical demonstrations of household appliances were given by Misses Van Rensselaer and Rose, of the department of home economics in Cornell University. "Biology in its Relation to Home Economics" was discussed by Dr. J. G. Needham, of Cornell University; "Political Economy in its Relation to Home Economics" was discussed by Professor Fetter and Professor Kemmerer, of the

department of political economy of Cornell University. "The Cost of Efficiency" was the topic of a series of lectures by Mrs. Ellen H. Richards, of the Institute of Technology, Boston, Mass. Some original work on "The Digestibility of Starch as affected by Cooking" was presented by Miss Edna D. Day, professor of home economics, University of Missouri; "Public Work for the Home" was discussed by Miss Caroline L. Hunt; "Some Problems in the Teaching of Dietetics" were presented by Miss Isabel Bevier, professor of household science in the University of Illinois; "Illustrative Material for Teaching Dietetics" was the subject of a lecture by Dr. C. F. Langworthy of the department of agriculture; "Dairy Bacteriology" and "Some of the Milk Products" were the topics treated by Dean Russell, of the College of Agriculture of Wisconsin, and Professor Stocking, of Cornell University. Moreover, the school enjoyed the privilege of a lecture by Professor L. B. Mendel, Sheffield Scientific School, on "Foods and Dietary Standards" and one by Professor N. Zuntz, of the Royal Agricultural College, of Berlin, on "Food Values."

Another feature which added to the profit and interest of the session was the fact that the members were able to avail themselves of the lectures given to the Graduate School in Agriculture then in session at Cornell. Those of particular interest to the members of the Home Economics Conference were those given by Professor Mendel, Dr. H. P. Armsby and Professor Zuntz, on the general subject of nutrition. Excursions to the hills and lakes in the immediate vicinity of Ithaca contributed much in the way of recreation and pleasure.

CAVERNS IN THE OZARKS

Early in May, the department of archeology, Phillips Academy, Andover, Mass., sent an expedition to Benton and Madison Counties, Arkansas, to explore certain caverns. These had been seen by Mr. E. H. Jacobs, who had been sent on a preliminary trip through the White River country. Mr. Jacobs reported more than thirty caverns in an extent of country eighty by forty miles.

Dr. Peabody, the director, and W. K. Moorehead, the curator, took the field for five weeks. From Fayetteville, Ark., they examined the country south and east through a region never before visited by archeologists. Four caverns were explored, one of these being in limestone and the rest in sandstone. The largest, Kelley Cavern, is about seventy meters in extent, with an overhang of thirty meters. The bluff is about fifteen meters high. The ashes range from one to three meters in depth. A force of twelve to fifteen men was employed for more than two weeks in removing the ashes from Kelley Cavern.

The character of the cave material differs essentially from that found on the surface of the surrounding village sites. Shallow metates are very numerous in the ashes of the cavern, thirty-seven having been found in Kelley Cavern alone. The peculiar character of the artifacts of the region deserves mention. There are no grooved axes—save one or two—no celts, no slate ornaments or problematical forms, no grooved hammers, no hematite implements, none of the spades and hoes common east and north, and only two pipes have been discovered in the entire region. These facts present an archeological problem of interest and importance to be solved at some future time.

The country is difficult of access, most of the caverns lying twenty to thirty miles from the railway. The elevation ranges from 1,300 to 1,600 or 1,700 feet. The collection brought to Andover totals about 1,200 specimens. On the fields throughout the entire region are great quantities of chips, spalls, hammerstones, knives and projectile points—a larger quantity than either Dr. Peabody or Mr. Moorehead ever saw in other portions of the United States.

Judging from the reports brought in by the mountaineers, there are large numbers of caverns in the region. These will be explored by Phillips Academy from time to time, permission having been secured from the Granger Kelley Lumber Company which controls upwards of 30,000 acres of land in the cavern country.

PRESS BULLETINS OF THE FOREST SERVICE

A clause in the Agricultural Appropriation Bill affecting the Forest Service has been the subject of a recent opinion by the Attorney General. The clause provided that no part of the appropriation for the Forest Service "shall be paid or used for the purpose of paying for in whole or in part the preparation or publication of any newspaper or magazine article, but this shall not prevent the giving out to all persons without discrimination, including newspaper and magazine writers and publishers, of any facts or official information of value to the public."

The question was submitted to the Attorney General by the Secretary of Agriculture, whether this provision of the law prohibited the sending to newspapers, writers, and others of such statements as it has been distributing in the past. To this inquiry the Attorney General replied: "You express the view that in distributing such information as is compiled and sent out by the Forest Service, especially to persons engaged in the practise or study of Forestry, and generally to the public at large through the newspapers and magazines, you are fulfilling the primary and fundamental duty imposed upon the Department of Agriculture by section 520 of the Revised Statutes. Information thus given out will be accompanied by a notice that it is sent in accordance with the proviso to the appropriation act of 1908. There will therefore be no discrimination; and you say, further, that no money will be paid on this account to any newspaper or magazine or to any newspaper or magazine writer or publisher, or to any person not regularly employed in the Forest Service. Obviously, such information as has been collated and distributed heretofore and will continue to be sent out is of value to the public, and certainly your determination that it is so, as head of the Department of Agriculture, is conclusive. Under this state of facts I can see no reason to doubt that your conception of your official duty in this respect is legally correct, and that the Forester may lawfully distribute information as proposed; and I am also of opinion that information requested by a newspaper or magazine writer or publisher may lawfully be sent in the form of a letter."

SCIENTIFIC NOTES AND NEWS

Professor George E. Hale, director of the Solar Observatory of the Carnegie Institution, has been elected a foreign correspondent of the Paris Academy of Sciences in the place of the late Asaph Hall.

The Chemical Society of the Netherlands has elected as honorary members Professor J. H. van't Hoff, of Berlin, and Professor J. van Bemmelen, of Leiden.

The Vienna Academy of Sciences has awarded its Lieben prize of 2,000 crowns to Professor P. Friedländer, of Vienna, for his work on thioindigo, and its Heidinger prize of 2,500 crowns to Professor M. Smoluchowski von Smolan, of Lemberg, for his work on the kinetic theory of molecular movements in liquids and gases.

Count Zeppelin, on the occasion of his seventieth birthday, has been awared an honorary doctorate of science by the University of Tubingen. He has also been made an honorary citizen of the cities of Constance and Stuttgart, and has been given the gold medal for art and science by the King of Wittemberg.

Professor A. Stodola, of the Zürich Polytechnic College, has been awared the Grashof gold medal of the Society of German Engineers.

M. Bouchard has been elected president of the Paris Academy of Sciences to fill the vacancy caused by the resignation of M. Becquerel to become permanent secretary. M. Picard succeeds M. Bouchard in the vice-presidency.

At the Massachusetts Institute of Technology Mr. Waldemar Lindgren, of the United States Geological Survey, has been appointed lecturer in economic geology, to succeed Professor James F. Kemp, of Columbia University.

A portrait photograph of Mr. Thomas A. Edison, showing him in bust length and nearly one half size, has been hung in the electrical engineering reading-room of the Massachusetts Institute of Technology. It was presented for the purpose by Mr. Charles L. Edgar, president of the Edison Electric Illuminating Company of Boston.

Dr. Alës Hrdlička, of the U. S. National Museum, is at present in field work among the Indians of the western states. He expects to return to Washington in September.

A caravan that has arrived at Lhasa from Leh, in the valley of the Indus, brings a report that Dr. Sven Hedin, the explorer, is in good health.

The monument in honor of Robert Bunsen, designed by Professor Volz, of Karlsruhe, was unveiled at Heidelberg on August 1.

Mr. Aniceto Garcia Menocal, who was born in Havana in 1839 and had served with distinction as an engineer in the service of the United States, died in New York on July 20.

Dr. Otto Pfleiderer, professor of systematic theology in Berlin and eminent for his work on the philosophy and the history of religion, has died at the age of sixty-nine years.

Sir Thomas Stevenson, M.D., scientific analyst to the British Home Office, known for his work in forensic medicine, died on July 28, at the age of seventy years.

Dr. Karl Han, professor of chemistry at Buda Pesth, has died at the age of seventy-four years.

Dr. H. Joly, professor of mathematics at Lausanne, has died at the age of forty-eight years.

The French Association for the Advancement of Science will hold its thirty-seventh annual meeting this year from August 3 to 10 under the presidency of M. Paul Appeil.

The eighth meeting of the Association of Economic Biologists was held in Edinburgh on July 28, 29 and 30, under the presidency of Mr. A. E. Shipley, F.R.S., who delivered a presidential address on "Rats and their Parasites."

Attention is again called to the approaching meeting of the first International Congress for the Repression of Adulteration of Alimentary and Pharmaceutical Products to be held in Geneva on September 8, 1908. A large number of members from the United States have already joined, but it is desirable to have the largest representation possible from this country. The congress is held under the auspices of the White Cross Society and the Swiss government. The fee for membership is $4. Dr. H. W. Wiley, of Washington, D. C., chairman of the American committee, will undertake to forward names of members and their subscriptions. Reduced rates will be given on steamship lines and on European railroads. Information will be sent by Dr. Wiley to all persons who desire to be apprised regarding the details of the Congress. Intending members are urged to send in their subscription at once.

The Philadelphia Academy of Surgery announces that essays in competition for the Samuel D. Gross prize of fifteen hundred dollars will be received until January 1, 1910. This prize is awarded every five years to the writer of the best original essay, not exceeding in length one hundred and fifty printed octavo pages, and illustrating some subject in surgical pathology or surgical practise, founded upon original investigation, the candidates to be American citizens.

The Board of Agriculture and Fisheries of Great Britain states that the presence of American gooseberry mildew on gooseberry bushes in commercial gardens in Kent has been confirmed. An order of the board requires all occupiers of premises on which the mildew exists to report the presence of the disease, under a penalty of £10. Gooseberry growers are advised to apply to the board for a leaflet describing the appearance of the disease, and giving the precautions that should be taken.

The *Journal of the American Medical Association* states that in Austria-Hungary, with a population of about 45,000,000, the annual mortality from tuberculosis is 750,000, or 14 per cent. of the total deaths from all causes. The northern parts of the empire show a ratio

of 38 to 48 per 10,000 inhabitants, while the southern parts have only about 22 to 30 deaths from tuberculosis to each 10,000 inhabitants. The highest mortality is found in Bohemia, with a mean of 54 in the north and 36 in the south, per 10,000. Vienna also has a high average mortality from this disease—42 per 10,000—but the hospitals as a center for a large area are largely responsible for this high rate.

UNIVERSITY AND EDUCATIONAL NEWS

Dr. D. K. Pearsons, of Chicago, has paid $25,000 to Beloit College and to Pomona College. Dr. Pearsons has now given more than $4,000,000 to small colleges.

Work is being pushed rapidly upon the engineering laboratory of the University of Nebraska, the foundations being laid and the workmen now having begun the walls of the lower story. It is to be completed during the coming year.

Professor Alfred D. Cole, of Vassar College, returns to the Ohio State University as professor of physics and head of the department, which now numbers eleven men. Professor B. F. Thomas, who has conducted the department for more than twenty years, will give up the executive work, but remains as professor of physics.

Professor Edwin M. Wilcox, of the Alabama Polytechnic Institute, has been elected to the position of botanist of the Experiment Station and professor of agricultural botany in the University of Nebraska. He has accepted the tender made him by the regents of the university, and will assume the duties of his new position the first of September, at which time his predecessor, Professor Heald, closes his work in Nebraska.

Dr. C. H. Shattuck, of Washburn College, has recently been called to the chair of botany and forestry in the State Agricultural and Mechanical College, at Clemson College, South Carolina.

In the University of Virginia Medical School, Dr. H. T. Marshall, formerly professor of pathology in Philippine Medical School, has been elected professor of pathology. Dr. J. A. E. Eyster, associate professor of physiology at Johns Hopkins has been elected professor of pharmacology and materia medica, and Dr. Carl Meloy, formerly instructor at Johns Hopkins in pathology, has been elected adjunct professor of pathology.

Dr. Aron, of Berlin, has accepted the position of professor of physiology in the Philippine Medical School.

C. W. G. Rohrer, B.Sc., M.D., M.A. (Wesleyan), has been appointed associate professor of pathology and assistant in genito-urinary diseases at the College of Physicians and Surgeons, Baltimore.

Dr. Clifton Durant Howe has resigned his position of associate director of the Biltmore Forest School, Biltmore, North Carolina, to become lecturer in forestry in the University of Toronto.

The following promotions were announced at the recent commencement exercises of the St. Louis University School of Medicine: Warren P. Elmer, M.D. (Michigan), and William Engelbach, M.D. (Northwestern), assistant professors of medicine; William W. Graves, M.D. (Washington University), assistant professor of nervous diseases; M. G. Seelig, A.B. (Harvard), M.D. (Columbia), assistant professor of pathology; James M. Wilson, Ph.B. (Cornell), M.D. (Rush), associate professor of embryology.

Dr. James Walker, of University College, Dundee, succeeds Professor Crum Brown in the chair of chemistry at the University of Edinburgh.

Dr. H. Dold, of Tubingen, has been appointed lecturer in bacteriology and comparative anatomy in the Royal Institution of Public Health, London.

Professor Volhard will retire this year from the directorship of the chemical laboratory at Halle. It is understood that he will be succeeded by Professor Daniel Vorlander, at present one of the heads of a division of the laboratory.

Professor Hans Horst Meyer, the pharmacologist, who was called to Vienna about three

years ago, has been asked by the senate of the Berlin University to accept the chair of pharmacology in that institution. The *Journal of the American Medical Association* states that in order to dissuade him from accepting this offer a deputation of ten of the most eminent members of the profession, all professors of the Vienna medical faculty, waited on him and asked him not to desert Vienna, both for scientific and national reasons. This unusual act not only caused a widespread sensation in the profession, but also reminded the government that it is its duty to retain such eminent men at any cost. Professor Meyer will not leave Vienna.

PROFESSOR HARMS, of Jena, has declined the call to Kiel in succession to Professor Bernhardt, in order that Professor Bernhardt may be free to remain in Kiel. It will be remembered that Professor Bernhardt was offered a chair at Berlin by the Ministry of Education, but declined because this action had been taken without consultation with the faculty.

DISCUSSION AND CORRESPONDENCE

A PROTEST

TO THE EDITOR OF SCIENCE: From the announcements made at the recent college commencements in this country I learned with regret the surprising and disappointing fact that at various medical colleges the chairs of physiology were filled by foreign appointments. Two Englishmen were called to fill the chairs of physiology and of physiological chemistry at the medical department of Cornell University. The chair of physiology at Tulane University was also filled by an Englishman. And a recent cable informs us that a young German was called to fill the chair of physiology at the school of medicine now in process of formation in the Philippines, presumably an institution of the United States government. Permit me to say that this is an anomalous state of affairs, and is disheartening to those who are interested in the development of an active scientific spirit among the younger medical men in this country. How can the talented men among the medical students in this country be persuaded to devote themselves to research, to a scientific career in the face of the tendency to fill desirable places with foreigners? The objections are not raised simply because the men called to the above-mentioned places are foreigners. Newell Martin who was called some thirty years ago to fill the chair of physiology at Johns Hopkins, or Jacques Loeb who was called some fifteen years ago to Bryn Mawr, were then also foreigners, and fortunate would this country be if again another Loeb or another Martin could be added to its store of first-class investigators and teachers. Indeed, all of us, old and young, would have been only too glad if one of these colleges would have made a serious effort to bring over from England such men as Sherrington or Starling. The objections are raised because the men called from abroad are not better than some of our own younger physiologists. Furthermore, in one instance the appointment to a chair of physiology is puzzling indeed. It is true the appointee is a meritorious histologist and microchemist and recently translated a book on the chemistry of the proteids. But one searches in vain through the English literature for an original contribution to physiology which is associated with his name. Why then was the preference given to him over such American men who have identified themselves with physiology and contributed meritoriously to its literature?

In conclusion I wish to emphasize that the above comment is made solely in the interest of the younger generation of physiologists of this country and to obtain justice for them, if possible, on future occasions. But under no circumstances should these remarks be interpreted as being derogatory to the scientists who have accepted these positions. It is no offence to them to assume that we have in this country physiologists who can bear comparison with them. Their coming here is an accomplished fact and they may be sure of a hearty welcome from the members of the scientific community of this country.

S. J. MELTZER

ROCKEFELLER INSTITUTE FOR
MEDICAL RESEARCH

A CONTINUOUS CALORIMETER

To the Editor of Science: In your issue of July 24 Professor Lyndley Pyle refers to the use of the continuous calorimeter by students of Washington University for the past fifteen years. It is gratifying to learn that the method has been so thoroughly tested elsewhere for this purpose. In taking up your valuable space in my article of May 15 I described a particular type of simple calorimeter that we have found most suitable for the elementary work. That this method is not generally used in place of the older and more troublesome method of measuring Joule's heat appears to be because sufficient attention has not been drawn to it. The directness, accuracy and ease of manipulation will appeal I think to all those who have charge of laboratory classes.

The method itself, is, of course, not new. Callendar used it more than twenty-two years ago at Cambridge for comparing the thermal and electrical units, but it was not until he came to McGill University in 1893 that steps were taken to thoroughly investigate the merits of the method. A continuous method was used by Graetz as early as 1882 for measuring thermal conductivities.

H. T. Barnes

McGill University,
July 29, 1908

SCIENTIFIC BOOKS

Publications of the Jesup North Pacific Expedition. Edited by Franz Boas. Leiden, E. J. Brill Limited; New York, G. E. Stechert & Co. 4to.

During the past year the following numbers of this publication have been issued:

The Lillooet Indians. By James Teit. (Vol. II., Part V.)

In this book Mr. Teit describes the customs of the Lillooet, a branch of the Salish Indians, who inhabit the valleys of the Coast Range of British Columbia, from Harrison Lake to the upper reaches of Fraser River. Mr. Teit visited the tribe twice, and describes in some detail the customs of both its lower and upper divisions. The plan of description is similar to that of Mr. Teit's well-known book on the Thompson Indians of British Columbia; the habitat and divisions of the tribe, material culture, warfare, games and pastimes, social organization and festivals, birth, childhood, marriage and death, and religion being taken up in detail. On the whole, the Lillooet resemble in their culture the tribes of the interior, but they form an interesting link between them and the coast tribes, having adopted many of the industries and a considerable part of the social traits of the coast tribes. Mr. Teit describes in detail how the influence of the coast culture gradually diminishes towards those divisions of the Lillooet that reside farthest away from the coast. Of special interest in the descriptions is the discussion of the imbricated basketry and of the basketry designs of the tribe, a subject which has received considerable attention in recent literature. The houses of the division of the tribe living near the coast were similar in structure to the large wooden houses of the Coast Salish, while the tribes of the interior lived in underground dwellings and in tents. Weaving like that produced by the Salish Indians of the Gulf of Georgia was confined to the Lower Lillooet. The tribe has been so much influenced by the whites that very few of the old specimens remain, and consequently not many of the objects in use among them formerly could be illustrated. The transitional stage in the social organization of the tribe is interesting from a theoretical point of view, in so far as it shows clearly how a semi-totemic organization may influence a people that in previous times was organized only in very loose village communities. At the present time the influence of the totemic organization may be observed particularly in grave-monuments which are still preserved, many of which represent figures of ancestors and of totemic beings. The religious concepts of the people differ only slightly from those of the Thompson Indians. The numerous rock-paintings in the Lillooet country have reference particularly to the puberty ceremonials, and are explained in a manner similar to those

of the Thompson Indians. The principal difference between the Salish tribes of the interior and the Lillooet in regard to their religious beliefs is based on the introduction of some of the secret societies of the coast. Mr. Teit's paper is the first fairly exhaustive description of the Lillooet, and supplants the earlier brief description given by Mr. Hill-Tout.

Archeology of the Gulf of Georgia and Puget Sound. By Harlan I. Smith. (Vol. II., Part VI.)

Mr. Smith's description of the archeology of the southern coast of British Columbia and the northern coast of the state of Washington is a continuation of his paper on the shell-heaps of the Lower Fraser River, published in Vol. II., Part IV., of this series. In the first part of the paper, which is fully illustrated with text figures reproduced from pen and ink drawings of specimens found in the region under discussion, the archeological finds between Comox in British Columbia, and Olympia, state of Washington, are described in some detail. The locations of shell-heaps, fortifications and village sites, are given; and wherever excavations were undertaken, the character of the site and the remains are described by the author. On the whole, it would seem that the culture of the area was quite similar in type to the culture of the modern coast tribes. However, some striking differences were found in various localities. Perhaps the most important of these is the proof which seems to have been definitely given by Mr. Smith of the close relationship of the prehistoric culture of southern Vancouver Island with that of the mainland and presumably the interior; so that it would seem that at an early time a wave of migration passed over the Coast Range westward to the coast, and across the Gulf of Georgia to Vancouver Island. This culture is characterized particularly by the occurrence of numerous chipped implements, of tubular pipes, and of other objects characteristic of the culture of the interior. In other places along the coast of British Columbia chipped implements are very rare, while on Puget Sound and on the outer coast of the state of Washington chipped implements begin to appear in greater number, and are apparently related to the types of Columbia River. Mr. Smith has also made full use of local collections, and has thus brought together an extended amount of material bearing upon the archeology of this region. Here are also found curious clubs of bone of whale and of stone which have often been claimed to be related to the clubs of New Zealand. Mr. Smith has succeeded in collecting illustrations of almost all the clubs of this kind that are known; and a discussion of this material shows very clearly that almost all of them may be referred to one single type, showing a bird's head surrounded by a head mask, which at the present time is characteristic of the western coast of Vancouver Island. Thus the theory of a foreign origin of this type would seem to be finally disposed of. Mr. Smith treats in a similar way the simpler forms of slave-killers from this coast and the peculiar single and double-bitted axes which are characteristic of Oregon. Another very peculiar type of specimens which is fully discussed in this book are the dishes from southern British Columbia and the Delta of the Fraser River, which have attracted the attention of archeologists. Mr. Smith has illustrated not less than nine of these, all of which show characteristic uniformity of type, and the provenience of which is restricted to a very small area. While the shell-heaps of the Fraser Delta have yielded a great many skeletons, skeletons are, on the whole, rare in the shell-heaps on the coast. Apparently this is related to the fact that in early times burials were not made in the shell-heaps, but in the cairns, while later on burials in canoes, and tree burials, seem to have been customary. Attention may also be called to the illustration and discussion of the interesting petroglyphs of the region between Comox and Nanaimo.

Kwakiutl Texts—Second Series. By Franz Boas and George Hunt.

The second series of Kwakiutl texts, so far as published, contains traditions of the more southern Kwakiutl tribes, and particularly the

important "Mink Legend" and the "Transformer Legend." The former occupies about eighty-five pages, and the latter about seventy pages, of the series. The texts, so far as published, were recorded by Mr. George Hunt, and were revised from dictation by F. Boas. Thus it happens that the whole series of texts published in the Jesup Expedition are recorded by Mr. Hunt. That the bulk of this work was intrusted to Mr. Hunt is due to the fact that the Kwakiutl mythology is enormously extensive, and must be obtained from representatives of all the different families to whom the family traditions belong. The writer of these lines, who is responsible for the collection, could not undertake this work himself, and for this reason he taught Mr. Hunt to write Kwakiutl, and, by carefully controlling his work, trustworthy material has been gathered.

From a broader ethnological point of view a series of this kind collected by a single native recorder is of course unsatisfactory, because the critical insight into style and contents require more varied material. For this reason I have collected a considerable amount of material from various sources, largely intended to control the results obtained by Mr. Hunt, and also to present different styles of story-telling and differences of dialect. It is a matter of regret that this material has not been included in the present volume which thus would have gained very much in scientific value.

Franz Boas

The Psychology and Pedagogy of Reading, with a review of the history of reading and writing, and of methods, texts, and hygiene in reading. By Edmund Burke Huey, Ph.D., Professor of Psychology and Education in the Western University of Pennsylvania. Pp. xvi + 469. New York, The Macmillan Co. 1908.

The experimental studies of the last dozen years in the physiology and psychology of reading constitute an interesting and an important line of advance in experimental psychology. Motived partly by logical, partly by linguistic, partly by pathological, and partly by pedagogical, as well as by purely psychological interests, the investigations of the reading process have materially increased our knowledge of the visual processes, both central and peripheral. They have enriched our experimental technique, and have furnished unusually satisfactory data for an investigation of the higher mental processes. Historically, physiological psychology received one of its most important early impulses from an investigation of speech defects. The lamented Wernicke found a discussion of the linguistic processes a convenient introduction to the more general discussion of mental life, and many another teacher of related disciplines has found it convenient to follow his example. It is not uninteresting that language seems destined to supplement its former services to psychology by furnishing us with the best available technique for an experimental analysis of the more complex elaborative processes.

Reciprocally it would be surprising if any real advance in our knowledge of the linguistic processes should be without influence on language itself and the teaching of language. I regard it as fortunate that, as far as reading is concerned, these practical deductions have been drawn thus far mainly by those whose experimental work guaranteed real information and a scientific attitude.

The present work is made up of four parts: Part I. is a résumé of experimental and analytic researches in the physiology and psychology of the reading process. It occupies about one third of the book. Part II. is a compact account of the history of reading and of reading methods, pp. 76. Part III. contains an illustrated discussion of the more important theories and practises in teaching reading, pp. 119. Part IV. discusses the hygiene of reading, fatigue in reading, suitable type, length of line, etc. The conclusion contains some interesting speculations as to the future of reading. The book closes with an excellent bibliography and an index.

One of the most striking characteristics of Huey's style is his unusually careful recog-

nition of the work of others. Writing for general as well as for scientific readers, he has ventured to set a standard of intellectual integrity quite unusual in popular works. I believe the general reader will appreciate the innovation. The author has further maintained a fine impartiality of statement. Few of us, doubtless, would have used exactly the same material. All must recognize the candor of his selections and his effort to discover the points of advance.

It is obvious from the nature of the contents that the different parts of the book must represent very different degrees of scientific assurance. Of this the author himself is thoroughly aware. Our present experimental knowledge of the reading of children does not warrant the psychological investigator in giving the weight of his investigations to any system of teaching reading, to any selection of material, or to any definite answer to the questions when, or how much. For the sake of psychology as well as for the sake of a possible science of experimental pedagogy, it seems prudent to make a sharp distinction between the results of scientific experiment and the empirical generalizations of educators. No other science has so many poor relatives urging extravagance. Probably in no other science is there greater need of guarding our work against premature popular exploitation and misrepresentation. Since many of the processes of adult reading are still imperfectly understood, while accurate knowledge of the reading of children and its development is conspicuously fragmentary, it seems probable that school methods in reading must rest, for the present at least, on empirical generalization rather than on scientific law. This, however, is the opportunity of experimental science rather than its reproach. The reviewer joins with the author in the hope that the present work will not only indicate possible lines of attack, but will also stimulate to renewed and if possible coordinated investigation.

Meantime it seems clear that the success or failure of any method rests quite as much on the insight of the teacher into the mental life of his pupils as on any of the formal details of his method. I believe that an adequate knowledge of the mental organization he is supposed to develop, as well as of the material and mental conditions of its realization, is one of the invaluable factors of a teacher's equipment. This factor it is the present privilege of the experimental psychologist to increase. On these grounds I venture the conviction that the book as a whole and in its several parts is an unusual contribution to pedagogical literature. I believe it should be in the hands of every teacher of reading. But the psychologist will welcome its careful summaries and its broad outlook as heartily as the teacher will welcome the new insight into the processes with which he must deal.

The book brings together an immense amount of material in unusually readable form. It seems destined to arouse interest and stimulate investigation in an important field.

Raymond Dodge

Wesleyan University

SCIENTIFIC JOURNALS AND ARTICLES

The contents of the June issue of *Terrestrial Magnetism and Atmospheric Electricity* are as follows: Portrait of E. van Rijckevorsel (frontispiece); "Magnetic Declination and Latitude Observations in the Bermudas," by J. F. Cole; "On Earth-currents and Magnetic Variations," by L. Steiner; "Return of the *Galilee* and Construction of a Special Vessel," by L. A. Bauer; "Magnetic Observations by the New Zealand Expedition to the Southern Islands," by H. F. Skey; "The Earth's Residual Magnetic Field," by A. Tanakadate, L. A. Bauer; "Biographical Sketch of E. van Rijckevorsel." Letters to Editor: "The Solar Eclipse of August 30, 1905, and Magnetic Phenomena," by C. Chree; "Regarding the Magnetic Effects of the Total Solar Eclipse of August 30, 1905," by Ch. Nordmann; "Principal Magnetic Storms recorded at the Cheltenham Magnetic Observatory (January–March, 1908)," by O. H. Tittmann. "Recent Determinations of the Solar Constant of Radi-

ation," by C. G. Abbott and F. E. Fowle, Jr. Notes: "Activity in Magnetic Work"; "Personalia." Abstracts and Reviews: W. van Bemmelen on "Registration of Earth-currents at Batavia," by L. Steiner; Cirera et Barcells on "Activité solaire et les perturbations magnétiques," by J. A. Fleming; Meyermann on "Korrektion der Reduktionsconstanten eines magnetischen Theodoliten," by J. A. Fleming. List of Recent Publications.

THE LIQUEFACTION OF HELIUM

INFORMATION communicated by Sir James Dewar to the London *Times* from Professor Kamerlingh Onnes, of Leiden, shows that helium is a liquid having a boiling point of 4.3 degrees absolute, which is not solid when exhausted to a pressure of ten millimeters of mercury, at which pressure the temperature must have been reduced to within three degrees of the absolute zero—*i. e.,* about one fourth of the temperature of hydrogen in corresponding conditions, as that again is about one fourth of the corresponding nitrogen temperature. If we could obtain another similar drop by the discovery of a gas still more volatile than helium we should have a liquid boiling about one degree above the absolute zero. The *Times* also gives a few notes upon the steps by which the liquefaction of helium has been reached. In 1895, by the application of the method of sudden expansion from high compression, Olscevski, starting from the temperature of exhausted air, failed to get any appearance of liquefaction. In 1901, Dewar, in the Bakerian lecture, described his repetition of that experiment, using liquid hydrogen under exhaustion instead of liquid air, again without obtaining any trace of condensation. Reasoning from the analogy of his experiments on the liquefaction of hydrogen, he showed that by regenerative cooling starting from the temperature of liquid hydrogen, we might expect to liquefy a gas whose boiling point might be as low as four or five degrees absolute. In his presidential address to the British Association in the following year he gave reasons for placing the boiling point of helium at that figure, showing at the same time how great are the experimental difficulties of getting within five degrees of absolute zero. In 1905 Olscevski repeated Dewar's experiment of 1901, using higher pressures, and reached the conclusion that the boiling point of helium must be below two degrees absolute, and that after all the gas might be permanent. The same experiment was repeated early in 1908 by Professor Onnes with a much larger quantity of helium than had previously been available, and he at first thought he had obtained solid helium, but found that the appearance was due to impurity in the gas. Dewar again repeated the experiment by circulating helium in a regenerative apparatus, but though he got cooling, he was baffled by the inadequacy of his supply of helium to maintain the cooling process sufficiently long to reach liquefaction. At last, by the experiment of July 10, Professor Onnes has definitely settled the matter. As new and richer sources of helium have been discovered, and its separation has been enormously facilitated by Dewar's charcoal method, it is possible that helium may become sufficiently abundant in cryological laboratories to be used as liquid hydrogen is now used in physical research.

SPECIAL ARTICLES

ELECTROMAGNETIC MASS

THE variations of meaning attached to d'Alembert's principle, that depend upon what we may call the genesis of the terms involved in its expression, has been insisted upon in a previous article.[1] We find a similar double chance open for instructive interpretation in many other equations of theoretical physics, among which we now select that important result in hydrodynamics which may be regarded as furnishing the original suggestion of "electromagnetic mass." For a solid of mass m moving in the line X through an ideal liquid free from boundary conditions, the familiar power equation is

$$Xu = d/dt(\tfrac{1}{2}mu^2 + \tfrac{1}{2}m_1u^2). \qquad (1)$$

Here X denotes the aggregate of force *external to the system* consisting of m and the

[1] SCIENCE, Vol. XXVII., p. 154.

liquid, and acting on m. The term $\frac{1}{2}m_1u^2$, then, is seen to express, in the first introduction of it, the kinetic energy associated with the liquid as a necessary consequence of moving m through it. The ratio of m_1 to m is calculable for various special assumptions.[2] Executing the differentiation with m_1 constant gives directly

$$X = (m + m_1)\,du/dt. \qquad (2)$$

If we accept this as an "equation of motion," just as it stands, and in the strict sense of d'Alembert, it is obviously not such for m alone, but for that mass plus liquid of constant volume, it is true, but of varying identity. That feature of elusiveness in the mass denoted by m_1 has undoubtedly favored the interpretation of the parenthesis as representing the "effective mass" of m under the conditions, among which must be included that X does not really comprise the total of external force acting on m, in conformity with the suppositions underlying equation (1). The completed equation of motion for m, in which any resistance R—frictional or not—offered by liquid must appear, is

$$X - R = m\,du/dt. \qquad (3)$$

Since $R = m_1\,du/dt$, therefore, because du/dt denotes the actual acceleration in both cases, we have before us another instance of change in reading, from mass-term to force-term, by transposing in the equation. And, from the point of view of equation (3), the power equation (1) can be adapted to the mass m exclusively, by placing $-\frac{1}{2}m_1u^2$ in the first member, as the negative work of the force R. As noted in connection with d'Alembert's principle, each view is justified so long as the proper context is retained, and we do not lose sight of the mental device that harmonizes them. A complete presentation includes both views, and does not overlook, either, the possibility of like alternative statement applying to any equation of motion with corresponding artificial basis. For example, if a mass m is acted upon by forces X_1 and X_2 that would produce separately accelerations a_1 and a_2, it is mathematically correct to write either form:

$$X_1 + X_2 = ma; \quad X_1 = (m - m_1)a; \qquad (4)$$

if $a = a_1 + a_2$ is the actual acceleration for the reference system used, and $m_1 = m\,a_2/a$. The "effective mass" of m when the force X_2 is ignored (or unrevealed by first analysis of the phenomena), would be greater or less than m according to the sign of a_2 determined by X_2. The fiction indicated here would serve no useful purpose in many classes of problems, but it offers a certain convenience in treating motions of bodies through media. The effect due to inertia of the medium, or its equivalent, finds adequate recognition by abolishing the medium, and at the same time adding to the inertia of the immersed body. The somewhat vaguely dispersed quality of the medium finds definite location in the bulk of the body.

Wherever the circumstances are thus thoroughly understood, the matter of choice in presentation is controlled completely by our preference; it is enough that the equivalence of two such modes of statement really covers the points aimed at, the confessed fiction being ranged with others like it in mathematical physics. But it is clear that different types of the external agencies called forces lend themselves to calculation as pseudo-inertia of the moving body itself with greater or less facility, the change of front being easiest when a resistance is involved whose magnitude is proportional to the acceleration of the body, as in the well-known hydrodynamical case cited above. Another side of these differences in the mathematical situation is the possibility that they afford for making conditions of unascertained physical nature reveal themselves experimentally as arising from force rather than from real inertia. Thus a resistance proportional to displacement might be identified by adjustment to equilibrium, as in stretching a spring, or charging a condenser; "terminal velocity" is characteristic of other forms of resistance, which prove to be proportional to various powers of speed. This second group includes the obstructive electromotive force of conductors to the passage of current through them, beside the more visible instances of such action. But a resistance pro-

[2] See for example, Lamb, "Hydrodynamics," p. 85, p. 130.

portional to acceleration would evade detection by methods of this kind, since it influences the motion of a body just like a mass measured numerically by the proportional factor. Considered as mass-term or force-term, the sign is reversed as required, and accurate balance with other impressed forces is never brought about. The acceleration that would be produced otherwise is reduced, but steady conditions enter at a finite value of actual acceleration. Supposing, however, that the density of the body falls off, and the "ballast" of real mass is thus diminished, equation (3) approaches a limit $X - R = 0$. And if the proportional factor m_1 of equation (2) be now increased, the acceleration corresponding to equality of X and R will grow less. Equilibrium of the body m can be approached asymptotically, therefore, somewhat as in the case of resistance (proportional to speed) due to eddy currents set up by motion in a magnetic field. For the hydrodynamic problem, the limiting condition $X - R = 0$ would correspond to a rigid massless shell forced through the liquid. The energy supplied would go directly into the latter, the shell transmitting the force X applied to it, undiminished by any distribution throughout its own volume. It is interesting to compare this with the application of the "equilibrium theory" to problems in acoustics.

Every essential aspect of the ideas connected with the equation of motion and the forms derived from it by transposition of terms is found repeated in the parallel electrical statement. The more fundamental form, for a circuit with impressed electromotive force, resistance, capacity and self-induction, is, with obvious notation,

$$E - E_c - IR = L\, dI/dt. \qquad (5)$$

Equation (5) is immediately consistent with the scheme devised by Newton and d'Alembert for the dual measure of forces, in terms of the favoring and hindering agencies themselves on the one hand, and their net result on the other. The former arise externally to the system moved, and the latter affords a mode of calculation in which no exciting stimulus appears directly. The recognition of the coefficient L as "electric inertia" is well rooted; and the proper sense in which the terms of the first member are all "external" is seen readily enough, even in its application to IR, though obscured here, to a certain extent, by the habitual elementary expression of Ohm's law in the form $E = IR$, without explicit recognition of it as involving terminal velocity and equilibrium. It is further apparent how the equation

$$[E - E_c - IR] - [L\, dI/dt] = 0 \qquad (6)$$

presents the idea of d'Alembert's principle, with considerations parallel in detail to those governing its use elsewhere. The proper establishment of these particular analogies is far-reaching enough to excuse their discussion with so much elaboration of emphasis on exceedingly simple conceptions. But there are some indications that original meanings here have become a little incrusted with the formalism of mathematics. A deliberate effort to restore them is not superfluous, if there is any habit of indifference toward fictitious forms of statement to be checked. However harmless such habits may be on familiar ground, they must tend to magnify the difficulties inseparable from attempts to explore and subdue new territory; and, on the other hand, the slightest improvement in giving natural and direct expression to essential phenomena is likely to find quick reward in more rapid advance or deeper insight. At this junction-point of the older mechanics with the modern dynamical treatment of electricity, the transfer of methods from one line of thought to the other calls especially for all precision of ideas that is possible, in view of the inevitable margin of vagueness associated with equations that have been generalized and extended so far beyond their first application.

With the introduction of electrons, an added element of definiteness is infused into electric inertia, and the new suggestion reacts also upon the finality of previous conceptions regarding all mass. We are asked to entertain the possibility that mass is everywhere expressible quantitatively in electromagnetic terms; and to acknowledge as an illusion any former conviction that mass is necessarily

constant. Until now, mass has been attributed to a body in the full sense of locating the mass entirely within the volume of the body, and measuring it by means of phenomena exhibited there. The essential property of mass may be put as its power to store energy in the kinetic form, receiving and retaining the energy passively; that is, acquiring and losing it only under the control of external influence. If we distinguish between "real mass" and "effective mass" in ordinary mechanics, they have in common the passive storage of kinetic energy, definite in amount for a given value of speed; but in using the latter, we assign to the body a certain amount of kinetic energy that is in fact not stored there. This part of the energy is obtainable *through* the body, perhaps, but not precisely *from* it. It happens that the effective mass is constant, under the conditions supposed to govern equations (2) and (3); but that type of supposition does not limit the entire range of the conception. This is evident from equation (4) in which m_1 may be variable. Neither is it essential, when we enter the field of generalized dynamics, that the storage of energy connected with inertia is demonstrably of a nature that would be described accurately as kinetic. The energy must indeed be stored; that is, be conservatively regainable; and this storage must be of passive character in the sense explained above —not accompanied by anything corresponding to resilience, nor automatically convertible like potential energy. These two conditions are sufficient as well as necessary; and the storage of energy ascribed to electromagnetic mass being in fact parallel with kinetic energy to this necessary extent, only one vital inquiry remains. This is concerned with what we may call the *location* of the energy. The generalized inertia will be effective rather than real, in proportion as the energy absorbed is not all stored in the body to which it is assigned conventionally; but is distributed throughout some region—or field—surrounding that body. And it is not excluded, as a limit, that the fraction of the total energy to be found within the boundary of the body itself is a negligible part of the whole.

It is of course nothing more than a commonplace to remark that the energy here in question, in the case of an ordinary electric circuit, is dispersed through a field, though the inertia is spoken of figuratively in association with the conducting track. It is also true that the factor L in equation (5) may be variable. But the electromagnetic theory of electrons is built on models supplied by finite circuits; and the more novel aspects of that theory modify nothing that is for our present purpose essential. Without going further into detail, it is sufficiently evident that the mass of an electron is "effective"; part of it, or perhaps all, attaching really to the electron's own magnetic field—of indefinite extent— though attributed to the diminutive bulk of the electron itself. In writing out dynamical equations for application to electrons, therefore, the inertia belonging to the region outside the boundary of an electron will register its influence on the equation of motion for the electron itself in a force-term, according to the general scheme of equation (4), the electron being the channel for transmission of energy to or from the medium. And if it should be finally established that the inertia of the electron proper is negligible or zero, the transmission would then be of perfect efficiency, corresponding to the condition $X=R$ in the text above. And on that supposition, again speaking of the equation of motion for the electron itself, the application of d'Alembert's principle becomes merely formal, since the terms corresponding to "forces of inertia" have vanished, leaving a zero of force in the first instance, instead of a zero resulting from the introduction of an equilibrant. The term R may indeed be read as a "kinetic reaction," but in a modified sense; it is no longer a reaction excited immediately in the electron by whatever applies the force X, but is the reaction of the medium against the attempt to move the electron according to certain laws. The term R may be more or less approximately proportional to the acceleration of the electron; and differently proportional for different types of acceleration. Hence arises the idea that the electromagnetic mass of an electron is not constant.

The consideration that saves the situation is that the entire effective inertia, no matter what may be its source, and where it may be located, is, as a fact, included in the calculations when mass, momentum, kinetic energy, etc., are regarded as attaching to the electron. This process of expression becomes feasible in terms that involve a physical property of the electron itself (its electric charge) and its kinematical elements (acceleration, velocity, etc.); so that to this extent the parallel is preserved with the mass-factor and the kinematical factors of ordinary mechanics. But it may be well, at intervals, while we take advantage of the undoubted convenience in these methods of presentation, to remind ourselves of their artificial nature, and then to employ their fictions consciously.

Should the suggestion prove true that all mass is an electromagnetic phenomenon, we shall be brought to confess that we have been using some fictions unconsciously; for example, in attributing kinetic energy to a mere cannon-ball which is more nearly a clearing-house for energies spread through cubic kilometers of medium. This would add only one item to a list already long enough, where the result of completer analysis is to substitute a complex process for the superficial and simple one. The tendency to identify quantities of energy with limited volumes of "bodies" seems strong enough to carry a good load of artificial convention. Witness potential energy, entropy, specific heat for constant pressure.

Frederick Slate
University of California

THE THIRTY-EIGHTH GENERAL MEETING OF THE AMERICAN CHEMICAL SOCIETY

I.

The thirty-eighth general meeting of the American Chemical Society was held at New Haven during June 30, July 1 and 2, in North Sheffield Hall, of Sheffield Scientific School, Yale University. President Hadley welcomed the visiting members and extended the buildings and accessories for their use and general convenience.

On Tuesday and Thursday afternoons, invitations were extended to the chemists to visit the rubber Works of L. Candee & Co., in New Haven, and the works of the New Haven Gas Light Co. Wednesday afternoon a special excursion was made to Ansonia to visit the works of the Ansonia Brass and Copper Company and the Coe Brass Manufacturing Company; at all of these places the visitors were courteously received and shown through the works in a very thorough and painstaking manner.

On Tuesday evening the local members of the society extended a complimentary smoker to the visitors at the Graduate Club House. On Wednesday a subscription shore dinner was given at the "Momanguin" on the east shore. Many of the visitors made use of the excellent salt-water bathing facilities at this place.

The attendance at this meeting was about 250. Greetings were received from Arrhenius, Emil Fischer, Roscoe, Ramsay, Van't Hoff, Julius Thomsen, Lunge and von Baeyer. A paper on "Agglutination and Coagulation" was presented by Savante Arrhenius, of Nobel Institute, Stockholm, and two papers were presented by Emil Fischer, one on "Polypeptides" and one on "Micropolarization."

The following addresses were given before the general assembly:

A. L. Winton, "Official Inspection of Commodities."

Philip E. Browning, "The Increasing Importance of the Rarer Elements."

Wm. D. Richardson, "The Analyst, the Chemist and the Chemical Engineer."

Thos. B. Osborne, "Our Present Knowledge of Plant Proteins."

Frank K. Cameron, "Some Applications of Physical Chemistry."

W. A. Noyes, "Chemical Publications in America in Relation to Chemical Industry."

Wm. Walker, "The Electrolytic Corrosion of Iron as Applied to the Protection of Steam Boilers."

W. E. Whitney, "The Research Chemist."

Wm. McPherson, "A Discussion of Some of the Methods used in Determining the Structure of Organic Compounds."

The following papers were read before the sections:

AGRICULTURAL AND FOOD CHEMISTRY

A. L. Winton, *Chairman*

The Determination of Cottonseed Hulls in Cottonseed Meal: G. S. Fraps.

The method consist of boiling two grams of the material, after extraction with ether, with 200 c.c.

of fiftieth normal caustic soda. The residue is filtered off, dried, weighed, ignited and weighed again. Cottonseed meals of high purity may yield 10 per cent. residue; hulls give 75 per cent. The freedom of the meals from hulls is judged from the percentage of the residue.

The Production of Active Nitrogen in the Soil: G. S. Frais.

This is a brief statement of results, which will be published in full elsewhere. It is impossible to condense the article more, but the author sees promise of securing a method for determining the needs of the soil for active nitrogen.

The Estimation of Dry Substance by Refractometer in Liquid Saccharine Food Products: A. Hugh Bryan.

The paper records results of comparative determinations of dry substance, by loss of weight at 70° in vacuum oven and from refractive index of the substance, using a table for transforming to dry substance. Samples of maple syrup, cane syrup, glucose, honey and cane and beet molasses were used, and results tabulated. In all the above substances except honey, the dry substance by refractometer agrees very closely with actual dry substance. Individual cases may show as high as two per cent. difference. With honeys the differences are larger, exceeding two per cent. in many cases. It is not certain whether the method for actual dry substance gives reliable results. For most liquid saccharine products the refractometer can be used for this determination and the results will be more nearly the actual dry substance than that derived from specific gravity.

The Determination of Sugar in Meats: A. Lowenstein and W. P. Dunne.

The purpose of the paper is to point out an error in the method for the determination of reducing sugar in meat, as outlined in the Official Methods of Analysis of the A. O. A. C. and in various government bulletins, to show the cause and magnitude of this error, and also the difficulties encountered in the manipulation of the method. A simple method is proposed which avoids the error referred to; avoids the use of lead acetate as a clarifying agent and permits of the determination of reducing sugars, succose and nitrates (saltpeter) in one portion of the sample. The method is rapid and accurate, its accuracy being indicated in several tables in the article.

Spanish Paprika: A. Lowenstein and W. P. Dunne.

This article furnishes data on the composition of a number of samples of pure Spanish paprika, of known origin and also on the ground commercial article imported from Spain. It points out the adulterants commonly employed and their means of detection, and particularly the detection of olive or other added oil. The presence of added oil is revealed by the determination of the iodine number and refractometer reading of the non-volatile ether extract, and also by the alcoholic extract, all of which are materially lowered by the addition of oil. It is convenient to make a tintometer reading of the alcoholic extract and thus record the color, the paprika usually being graded according to its color.

The Determination of Diastatic Power: A. W. Meyer and H. C. Sherman.

This was a preliminary notice of a somewhat extended investigation of the methods for the quantitative determination of the activity of amylases of different origin. The saccharification of soluble starch by taka-diastase and pancreatin has been studied. The work is still in progress and will be reported in detail later.

The Detection and Identification of Certain Reducing Sugars by Condensation with p-Brom-Benzyl-Hydrazide: E. C. Kendall and H. C. Sherman.

Under the conditions which have been worked out this reaction affords a fairly delicate method for the detection and identification of glucose, galactose, mannose or arabinose.

The Composition of Known Samples of Paprika: R. E. Doolittle and A. W. Ogden.

As indicated by the title, this paper is a statement of the results obtained in the examination of a large number of paprikas obtained in the whole pods direct from producers. A method for detection of added oil by means of determination of iodine number of ether extract is given.

Gluten Feeds—Artificially Colored: Edward Gudeman.

The paper gives processes of the manufacture of gluten feeds, by-products in the corn starch, glucose and starch sugar industries. Methods for examinations of gluten feeds for added colors given. Examination of a large number of gluten feeds, sold in the United States (62 samples from agricultural experiment stations), showed over 75 per cent. to have been artificially colored with coal-tar colors. The author considers the artificial coloring of feed stuffs as contrary to the federal food act and many state food acts, unless such products are specifically labeled as artifi-

cially colored. The purpose of adding color to gluten feeds is only for deception, to make them appear better than they really are or to hide some inferiority, such as the use of rotten, burnt or fermented corn.

The Detection of Small Quantities of Turpentine in Lemon Oil: E. M. CHACE.

The method is based upon the different forms shown by the nitroso chlorid crystals of pinene and limonene when examined under the microscope. The nitroso chlorids of the terpenes of the sample to be examined are prepared from the first 5 per cent. fractionally distilled by means of a Ladenburg 3-bulb flask or with a Glinsky fractionating column, the latter giving the better results. The crystals are purified by solution in chloroform and recrystallization from methyl alcohol. Olive oil is used for mounting.

The Manufacture of Lemon Oil in Sicily: E. M. CHACE.

The location and a brief description of the principal centers of the production of lemon oil in Sicily were described. Three methods of production are used in the island. The two-piece method in which the lemon is cut in half, the pulp removed and the oil extracted by means of pressure within a sponge is used in the Messina, Etna and Syracuse districts. The three-piece method, in which the lemon is pared, the skin being removed in three pieces, leaving the pulp with a small portion of the skin adhering to each end, the parings being pressed against a flat sponge for extraction, is confined to the Barcelona and Palermo districts. The use of machines in the production of oil is confined to the province of Calabria upon the mainland, less than 5 per cent. of the total output being thus manufactured.

The Influence of Environment on the Composition of Wheat: J. A. LECLERC and SHERMAN LEAVITT.

Crops grown from the same seed at three points of widely different climatic conditions, such as Kansas, California and Texas, forming a so-called triangular experiment, and similarly at South Dakota, California and Texas, showed a marked difference in the protein content, the weight per bushel, the percentage of starchy grain and total sugar content. Kansas produced invariably a high protein and California a low protein and high sugar content wheat. Wheat grown in California one year was found to double its protein content when grown in Kansas the next; the reverse was found to be true when Kansas seed was grown in California. These differences are due to climatic conditions. The composition of the seed seems to exert no influence on the composition of the crop.

The Analysis of Meat Extracts and other Meat Preparations: JOHN PHILLIPS STREET.

Twenty-two paste extracts, 13 fluid extracts, 4 meat juices and 3 meat powders were very completely analyzed. The determinations made were water, alcohol, ash, fat, chlorin, phosphoric acid, potash, acidity to phenolphthalein and litmus, total nitrogen, insoluble and coagulable nitrogen, syntonin, ammonia, nitrogen precipitated by tannin-salt and by zinc sulphate, meat bases, creatinin, creatin and total purins. In general the extracts contained excessive amounts of added sodium chlorid, in one case over 25 per cent. The biuret reaction failed in the zinc sulphate filtrate in all the pastes, but as tannin-salt in every case precipitated much more nitrogen than zinc sulphate, on the average about 2 per cent., it is suggested that this difference may be largely due to Fischer's non-biuret-reacting polypeptides. Attention is called to the false and misleading claims made by many of the manufacturers for the extracts. The methods of analysis used are given in detail, and a bibliography of the subject from the analytical standpoint, with 221 titles, is appended.

Commercial Preservation of Flesh Foods: W. D. RICHARDSON.

The means used at the present time for food preservation may be classified under four principal heads: (1) heat sterilization, (2) desiccation, (3) low temperatures, (4) the use of antiseptics. Any of these processes may be carried out in the absence of air or oxygen. All of these methods have been used by primitive man singly and in combination from times of greatest antiquity, and are used by primitive tribes to-day. Modern science has extended the means of carrying out the various methods of preservation, but has made only one original contribution to the art, namely, the use of small quantities of noncondimental antiseptics. Of the various methods of preservation the application of low temperatures would seem to be the best, inasmuch as little or no alteration in composition occurs under this application and at most there is a change in physical structure which does not affect composition or nutritive value.

Chemistry of Frozen Beef and Poultry: W. D. RICHARDSON.

Analyses of fresh and frozen poultry and of fresh and frozen beef (in the latter case the cruror triceps was used on account of its leanness, size and uniformity of structure) were made at intervals for a period of one and a half years. The determinations were: moisture, ash, fat, ammoniacal nitrogen (by two specially devised methods), and on the cold-water extract, total solids, ash, organic solids, total nitrogen, coagulable nitrogen, albumose nitrogen, meat-base nitrogen and acidity calculated as lactic acid. From these determinations no alteration was discovered for the period mentioned in the composition of either beef or poultry. These results were borne out by practical cooking tests. The work will be continued for an indefinite period.

Histology of Frozen Beef and Poultry: W. D. Richardson.

Histological examination of frozen beef and poultry for a period of one and a half years failed to detect any progressive alteration in the structure of the muscular tissues. The samples frozen for a short period of time, when properly thawed, appeared to have the same structure as those frozen for a longer period. When muscular tissues freeze, the water which begins to separate as ice at — 0.4° C. solidifies outside the muscle fibers, and by progressively accumulating between the fibers as it freezes, causes them to appear much smaller than normal and of irregular form. in fully frozen samples, temperatures below — 9° C., the ice areas are usually greater than the areas of muscle fiber, either in cross or longitudinal sections. On account of these ice areas it is impossible for bacteria to penetrate into frozen meats. From the laws of cryoscopy, the solution which remains after the freezing out of so much ice must be very concentrated, and it is altogether likely, from experiments already conducted, that microorganisms are unable to multiply or remain active in such a medium. On the other hand, it is probable that microorganisms if artificially inoculated into meats under these circumstances would certainly lose their vitality and die. Experiments on this point are not yet concluded. If frozen muscular tissue is thawed rapidly, the normal appearance is not resumed. On the other hand, if thawed sufficiently slowly, a histologic picture very close to the normal is obtained.

A Method for Detecting Synthetic Color in Butter: R. W. Cornelison.

The clear fat is shaken with glacial acetic acid, and the acid, after being separated from the fat, is tested by the addition of a few drops of mineral acid, particularly nitric. A pink color developed in samples containing the several azo colors which were tried. The color of the acetic-acid extract is also noteworthy. Reactions of several vegetable colors also are given. The writer makes an earnest plea for the use of the true chemical names of colors in place of the fanciful and much-confused names in use in the trade.

The Composition of Milk from Dutch Belted Cows: Hermann C. Lythgoe.

The Dutch belted cattle are all jet black with the exception of a broad belt of pure white encircling the body. No white is admissible in the black, and the belt must be free from black. There are but few herds of this breed in this country, although single cows in mixed herds are not uncommon. There has been examined in the laboratory of food and drug inspection of the Massachusetts State Board of Health the milk of 23 registered, and of a few unregistered, Dutch belted cows. In general this milk is better than that produced by the Holsteins, being characterized by a much higher fat and refraction of the milk serum. The cows were milked in the presence of an inspector or analyst of the state board of health. The analyses of the twenty-five samples of milk reported may be summarized as follows:

Per Cent.	Total Solids
14	1 sample
13 –14	2 samples
12.5–13	3 samples
12 –12.5	8 samples
11.5–12	4 samples
11 –11.5	6 samples
10.93	1 sample

Per Cent.	Fat
Above 4	2 samples
3.5–4	11 samples
3 –3.5	12 samples

Per Cent.	Solids not Fat
9 –9.75	4 samples
8.5 –9	8 samples
8 –8.5	9 samples
7.73–8	4 samples

Studies on the Action of Heat on Milk: R. R. Renshaw and J. C. Ware.

The following determinations were made every one fourth hour on milk heated at different temperatures between 60° and 85° C. for two and a half hours with and without varying amounts of formaldehyde: sugar, polarimetrically and gravimetrically, acidity, alkalinity, total nitrogen and total phosphorus on clarified filtrate. Lactose in a mixed citrate-phosphate solution having an alkalinity of 19° to lacmoid was not changed on heating to 85°. The authors conclude

that the decrease in sugar is not due to caramelization, but to a greater bacterial activity throughout the first stages of the heating.

The Status of Silicon in Certain Plants: W. E. Tottingham.

Evidence has been secured which points strongly to the presence of organic silicon compounds in certain plants. Moist oxidation of 20 per cent. acetic acid and 95 per cent. alcohol extracts from green Gramineæ (mostly barley) has shown the presence of forms of silicon which are lost upon incinerating such extracts. Of the total silicon in the acetic-acid extract, 31.73 per cent. was lost in this manner. With the alcoholic extract 18.42 per cent. was lost in the same manner. The silicon in young fruiting fronds of *Equisetum arvense* was found to be 26.7 times more soluble in 95 per cent. alcohol than in distilled water. Evidence has been obtained of the existence of silicon as a constituent of volatile compounds in plants. The distillate by vacuum distillation of 95 per cent. alcohol extract of Gramineæ contained .0123 gram SiO_2. A current of air was passed over green fruiting fronds of *Equisetum arvense* while drying at 97° C., and then was drawn through an absorbing train. By oxidation, .0023 gram SiO_2 was recovered from the water condensation and .0039 gram from the conc. H_2SO_4 absorption. These data strongly suggest the occurrence of organic and volatile silicon compounds in plants. They further open the field for future study on the relation and importance of silicon in plant nutrition.

Abstracts have not been received for the following papers:

The Determination of Reducing Sugars: Fritz Zerban.

Determination of Volatile Fatty Acids: Edward Gudeman.

Effect of Heat upon Physical and Chemical Constants of Cottonseed Oil: Elton Fulmer.

The Determination of Total, Fixed and Volatile Acids in Wine: Julius Hortvet.

The Chemistry of Durum Wheat Flour: E. F. Ladd.

Water and Starch in Meat Products: Floyd W. Robison.

The Determination of Tin in Canned Apple Juice: H. C. Gore.

The Toxicity of Ferrous Sulphate and of Acids to Rye and Barley Seedlings: Burt L. Hartwell and F. R. Pember.

ORGANIC CHEMISTRY

Wm. McPherson, *Chairman*

The Anhydrides of Meta- and Para-phthalic Acids: John E. Bucher and W. Clifton Slade.

When meta-phthalic acid is dissolved in acetic anhydride and the excess of reagent distilled a viscous oil is obtained. On heating this in vacuo at 200° C., a solid residue of meta-phthalic anhydride is obtained. This substance is insoluble in dilute sodium carbonate but dissolves rapidly in sodium hydroxide solutions. Water converts into the corresponding acid very easily in the presence of solvents. The method of preparation and the properties of para-phthalic anhydride are similar to those of the meta compound.

The Formation of Naphthalene Derivatives from Phenylpropiolic Acid and its Substitution Products: John E. Bucher.

Phenylpropiolic acid heated with acetic anhydride gives a quantitative yield of 1-phenylnaphthalene-2, 3-dicarboxylic anhydride. This saturated compound on oxidation yields o-benzoylbenzoic acid, diphenyltetracarboxylic acid, 1-phenyl-phenyl-o-glyoxyltricarboxylic acid and probably benzenepentacarboxylic acid. The above polymerization has been shown to be a general reaction as piperonylpropialic, o-chlor-, m-chlor-, m-nitro-, p-chlor-, p-iodo-, p-nitro- and p-methoxy-, phenylpropiolic acids all yield saturated anhydrides and nearly all of these have already been shown to be derivatives of 1-phenylnaphthalene. A number of practical applications of this synthesis were pointed out.

Chemical Publications in America in Relation to Chemical Industry: W. A. Noyes.

The American Chemical Society is the only large chemical society in the world which attempts to provide adequately both for the needs of those who are engaged in the applications of chemistry to the industries and to chemical engineering and of those who are engaged in teaching and in the prosecution of researches which have no immediate practical bearing. The dues of the society were increased by only three dollars when the *Chemical Abstracts* was established, while it costs between five and six dollars per member. The expenditures of the society somewhat exceed its receipts, but the rapid growth in membership indicates that the policy which has been adopted will be permanently successful. The new *Journal of Industrial and Engineering Chemistry* is to be

sent to all the members of the society. Only by uniting in the support of all the publications can we succeed in fulfilling the purpose of the society, which is to care adequately for the interests of all classes of chemists. The benefits of the society are extended freely to any one who is willing to pay the dues. This has not, however, caused the membership of the society to be non-professional. There are only a few members who are not actually engaged in chemical work.

Rearrangements in the Camphor Series: the Structure of Laurolene: W. A. NOYES and C. G. DERRICK.

An attempt is being made to gain a better insight into the nature and cause of some of the puzzling rearrangements which occur so frequently among the derivatives of camphor. The oxidation of laurolene, C_8H_{14}, has given a diketone, $C_8H_{14}O_2$. It seems almost certain that this ketone must contain two groups of the structure CH_3CO. The melting point of its disemicarbazone indicates that it is not 2, 7-octanedione, which would be formed if laurolene were tetrahydro-ortho-xylene. The activity of laurolene also excludes that formula. The formula of Eykmann, according to which laurolene is 1, 2, 3-trimethylcyclopentene, is now the most probable.

Studies in Nitration, VI. Melting Points of Mixtures of Ortho- and Paranitraniline: J. BISHOP TINGLE and H. F. ROLKER.

The authors have shown previously that the melting points of mixtures of o- and m- and of m- and p-nitranilines form regular curves, whereas the mixtures of o- and p-nitraniline melted at highly irregular temperatures. A fresh series of mixtures of these two isomers has been prepared with additional precautions to secure homogeneity and also constancy of composition. The m.p. of each mixture was determined, the material was allowed to solidify and it was then melted once more. The results have been plotted in the form of two curves which do not exhibit a very simple relationship and which are both highly irregular. Moreover, the melting points of mixtures of the o- and p-nitranilines are not nearly so sharp as those mixtures of the other isomers. Suggestions were made as to the possible cause of these phenomena which are probably due to polymorphism.

Action of Sodium on Certain Esters: J. BISHOP TINGLE and ERNEST E. GORSLINE.

According to Claisen's hypothesis, which was adopted subsequently by Nef, the formation of ethyl acetoacetate, $CH_3C(OH):CHCO_2C_2H_5$, from ethyl acetate, $CH_3CO_2C_2H_5$, depends upon the previous production of sodium ethylate, which is the active agent in producing the condensation. A. Michael, on the other hand, considers that sodium reacts directly with ethyl acetate, forming such a compound as $NaCH_2CO_2C_2H_5$ or $CH_2:C(ONa)\text{-}CO_2C_2H_5$. We have purified ethyl acetate with great care by a new method and find that the specimens obtained in this way react very readily with sodium, either alone or in the presence of ether. Experiments have been carried out on the interaction of sodium and certain esters. It is found that ethyl malonate, $H_2C(CO_2C_2H_5)$, ethyl chlormalonate, $Cl(CO_2C_2H_5)$, and ethyl dimethylmalonate, $(CH_3)_2C(CO_2C_2H_5)$, react with 2, 1 and 4 atomic proportions of sodium, respectively. Ethyl phthalate and the metal react, but an insoluble coating is formed over the surface of the wire so that the action quickly ceases. Our study of the catalytic effect of ether, pyridine and quinoline in promoting the Claisen reaction (acetoacetic ester condensation) has been extended. The results of our work support Michael's explanation of the reaction and show that the Claisen-Nef hypothesis is open to the gravest doubt.

Intramolecular Rearrangement in the Phthalamidic Acid Series: J. BISHOP TINGLE and H. F. ROLKER.

In conjunction with Messrs. Cram and Lovelace, the senior author has shown previously that phthanilic acid, $C_6H_5NHCOC_6H_4CO_2H$, changes very readily in the presence of amines to phthalanil,

$$C_6H_4\left\langle {CO \atop CO} \right\rangle NH.$$

It was suggested that the change in the equation was preceded by the formation of a salt, $C_6HNHCOC_6H_4CO_2NH_3R$. This hypothesis has been confirmed by the preparation of several such salts, the stability of which is found to vary according to the nature of the amine and also to that of the group R in the parent acid $RNHC_6H_4CO_2H$. In addition to this reaction a second one occurs which consists in the replacement of the group R in the original acid by a different complex R′ derived from the amine thus, $RNHC_6H_4CO_2H + R'NH_2$, $R'NHC_6H_4CO_2 + RNH_2$. This new acid may then pass into the imide (anil). Finally there is evidence showing that occasionally some diamide, $C_6H_4(CONHR)_2$, may be formed. The reactions have been studied in detail with a considerable number of acids and

amines, and the influence of various solvents and also the temperature effects have been determined.

A Wax Acid from Soils; Agroceric Acid: Oswald Schreiner and Edmund C. Shorey.

In the examination of a black clay loam from North Dakota there was obtained by treatment with boiling 95 per cent. alcohol a colored extract from which a micro-crystalline precipitate separated on cooling. By washing with cold alcohol and recrystallizing, this can be obtained free of color. On drying this purified precipitate and treating with cold ether it is divided into two portions. The ether soluble portion crystallizes on evaporation of the ether in minute leaflets, melting at 72–73° C. The physical and chemical properties of this body place it among the fatty acids found in waxes. Elementary analyses correspond with the formula $C_{21}H_{42}O_3$, the hypothetical acid of a lactone found in carnauba wax. The name agroceric acid is proposed for this body.

A Cholesterol Body in Soils; Agrosterol: Oswald Schreiner and Edmund C. Shorey.

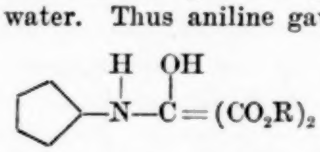
When the alcoholic extract of the soil referred to in the first paper is separated from the precipitate, which forms on cooling, and is evaporated to small volume, a resinous dark-colored mass is obtained. Cold ether dissolves a portion of this, including the coloring matter. Spontaneous evaporation of the ether leaves again a resinous dark-colored mass. Treatment of this with cold absolute alcohol removes the coloring matter and leaves a white crystalline residue. Purification of this by recrystallization yields a body crystallizing in plates resembling those of phytosterol, melts at 237° and gives the cholesterol reaction with acetic anhydride and sulphuric acid. Elementary analysis gave figures corresponding to the formula $C_{26}H_{44}O$. The name agrosterol is suggested for this compound.

Studies in Catalysis; Some Practical Results and their Application to the Synthesis of Some Esters: Isaac K. Phelps.

A study of the quantitative yields of various esters in a special form of apparatus under known conditions of temperature and in the presence of various substances as catalyzers. From the present evidence, it seems that each individual catalyzer has its own individual effect. Zinc chloride in the presence of alcohol and hydrochloric acid is the most efficient chloride studied; next in catalytic effect come stannic, cupric and mercuric chlorides, followed by bismuth and antimony chlorides. Potassium chloride appears inactive; the following chlorides act as negative catalyzers, sodium, lithium, ammonium, aluminum and calcium. The list for sulphates in order of efficiency is sulphuric acid, acid sodium sulphate, ammonium, potassium, aniline and pyridine acid sulphates. Zinc bromide and hydrobromic acid act less efficiently as ester-forming catalyzers as the temperature rises. In esterifying malonic acid, 96.1 per cent. yield was obtained: cyanacetic acid 97.1 per cent. of the theory; applying these results to the synthesis of malonic ester from chloracetic acid, it appears that conditions of quantitative reactions are found with a yield of 87 per cent. from chloracid of 95 per cent. purity; or in synthesizing similarly cyanacetic ester a yield of 85 per cent. from acid of the same purity.

Addition Reactions on Methyl Oxomalonate: Richard S. Curtiss and F. G. C. Spencer.

Methyl oxomalonate can only be made perfectly anhydrous by distilling methyl dihydroxymalonate with phosphoric anhydride. It gives with ammonia and its derivatives compounds more or less unstable, which represent the class of hypothetical intermediate addition products, supposed to be first formed when amines, etc., act on aldehyde or ketone groups, and which pass into the final stable end product by loss of the elements of water. Thus aniline gave



Urethone reacts in like manner. More positive ammonias add on two oxomalonate radicles. Alcohols and even the acids add on the carbonyl group of these esters. The products which are tartronic ester derivatives are unstable and readily dissociate into their constituent parts, in moist air or simply by heating. The studies on these and similar substances are being continued.

Methods for the Determination of Salicylates: Atherton Seidell.

In looking for a reaction upon which to base a quantitative method for the determination of the salicylic acid radicle, the author found that bromine acting upon a concentrated hydrochloric acid solution of salicylic acid yielded di-brom-salicylic acid (m. pt. 220°) and in the presence of relatively small amounts of H_2O and at 80–90° the reaction proceeded quantitatively, although rather slowly. The suggested method is as follows: The weighed sample of 2–3 grams of salicylate is dissolved in 100 c.c. of water. 3–5 c.c. portions of this solution measured accurately

from a burette are mixed with 10–20 times the volume of concentrated hydrochloric acid in a glass-stoppered bottle. Standard 0.2 normal potassium bromate solution is run in slowly until a persistent pale yellow color remains, the solution then warmed and shaken until the color disappears, more bromate then added, and the color discharged by further heating and shaking; this alternate adding of bromate and heating continued until the temperature has reached 80–90° and the pale yellow color produced by two to three drops of the bromate remains at least fifteen minutes. Four atoms of bromine per one molecule of salicylic acid are used. The reaction is slow and patience is required, but with care satisfactory results may be obtained.

Abstracts of the following papers have not been received:

On Certain Derivatives of Tetrachlororthoquinone: C. Loring Jackson and H. A. Flint.

On the Reactions of Tautomeric Acids and their Salts with Diazoalkyliden and with Alkyl Halides: S. F. Acree.

On Furoyl Acetic Ester and its Pyrazotone Derivatives: Henry A. Torrey and J. E. Zanetti.

On Rosocyanine: C. Loring Jackson and Latham Clarke.

The Nitration of p-Tolylglutaric Acid: S. Avery.

The Action of Phosphorus Trichloride on Organic Acids: Wm. McPherson and Howard J. Lucas.

Comparison of Isomeric—N:C(OR) *and* NR:CO *—Compounds in the Quinazoline Group:* M. T. Bogert and C. E. May.

4, 6-Diamino Isophthalic Acid and Some of its Derivatives: M. T. Bogert and Alfred H. Kropff.

3-Amino Phthalic Acid and Some of its Derivatives: M. T. Bogert and F. L. Jouard.

The Colored Salts of Schiff's Bases: F. J. Moore.

The Oxidation and the Reduction of b-g-Diphenyl-g-Cyanbutyric Acid: S. Avery.

An Insoluble Congo Red; a White Derivative of Congo Red: Irving W. Fay.

On an Oxidation Product of Tetrabromorthoquinone: C. Loring Jackson and H. A. Flint.

INDUSTRIAL CHEMISTRY

W. D. Richardson, *Chairman*

The Cleaning of Blast Furnace Gas: G. D. Chamberlain.

A review of methods of cleaning and present tendencies and practise. The cleaning divided into two phases. (1) A preliminary scrubbing either dry or wet, or a combination of the two, for fuel purposes—hot blast stoves and boilers. (2) Fine washing for gas-engine use. The raw gas carrying from 1 to 5 grams of dust per cubic foot is cleaned down to .1 to .5 for fuel and to .005 gram per cubic foot or less in fine gas for engine use. The magnitude of the problem is suggested in the fact that approximately six tons of gas are incidentally produced for each ton of pig-iron made.

Determination of Nickel and Chromium in Steel: E. D. Cambell.

The object of this research was to modify the cyanide-iodide method for the determination of nickel, in such a way that a satisfactory titration could be made in the presence of iron. The titration of nickel with potassium cyanide, using silver iodide as indicator, was proposed by the author in 1895, but in the original method the nickel was separated from the iron before titrating. In the new method the iron is kept in solution as double pyrophosphate by means of sodium pyrophosphate, copper when present is avoided by dissolving in dilute sulphuric acid. Chromium is determined in the same sample as that used for the nickel by a slight modification of the Galbraith method.

Application of Ericsson's Lead Method to the Analysis of Spelter, Zinc and Lead Ores: Eric John Ericsson.

The method was described in the September issue, 1904, of the *Journal of the American Chemical Society*. The lead is brought into solution as nitrate, ammonia and ammonium persulphate added in excess and boiled. The resulting lead peroxide is filtered off, washed. Filter with precipitate are thrown back into beaker in which precipitation was made, excess of acidulated hydrogen peroxide added and stirred until the lead peroxide is dissolved, the excess of hydrogen peroxide is measured by standard potassium permanganate of such strength that each tenth of a cubic centimeter = 0.01 per cent. lead when 1.92 grams are taken as in low-grade ores and the determination of lead in zinc ores. In the case of spelter 19.2 gram sample are taken when each tenth of the potassium permanganate solution = 0.001 per cent. lead. It is believed the new method will fill a long-felt want, since we have not heretofore had a reliable method for low-grade ores. It will be found on investigation to be a marvel of accuracy.

The Crystallization of Soap: W. D. Richardson.

When crystals form in transparent soap they usually first appear as bundles of two or three long slender needles pointed in opposite directions from a central nucleus. Later more needles appear until the crystal looks something like two whisk-brooms with the handles together. The nucleus does not appear to grow larger with age, but more needles form from the center until a circular disk of radiating needles is formed and this may increase in size indefinitely. Sometimes only one or two crystals will form in a bar of soap, at other times they will form in such numbers that the whole bar of soap becomes opaque and at a little distance can not be distinguished from a piece of opaque cold-made soap. In cold-made soap the same crystal-form is observed, with radiating needles starting from nuclei of fibrous structure which occupy the spaces originally occupied by fat globules in the emulsion of fat and alkali solution. It is suggested that in old bars of ordinary curd soap the same structure may be found, although it is difficult to observe microscopically. The composition of the nuclei has not been determined.

Glue Standards and Methods for Determining their Viscosity and Jelly Strength: Jerome Alexander.

Although the viscosity and jelly strength of glues and gelatines are the most important test figures, no standard methods have been agreed upon for their determination. It is proposed to establish as standards the methods described by the author in *J. S. C. I.*, Vol. 25, p. 158, which in brief are as follows: To determine—*Viscosity.* A glass pipette of convenient size and construction, which delivers 45 c.c. of water at 80° C. in fifteen seconds. Exact measurements and instructions for making the pipette are given. *Jelly Strength.* The jelly tester described, by which is determined the weight required to effect a certain compression of an unsupported block of jelly of definite size, composition and temperature (see also U. S. Patent No. 882,731). Sixteen uniformly graduated grades of glue were selected as standards, which include not only the so-called "Cooper grades," but also all other grades of glues and gelatines. The standards vary *per grade* under the conditions given, about one second in viscosity, and about 622 grams (22 oz.) in jelly strength.

Abstracts have not been received for the following papers:

Gas Producer Practise: George C. Stone.

The Influence of Fine Grinding on the Ferrous-Iron and Water Content of Minerals: W. F. Hillebrand.

The Stability of Rosin at Slightly Elevated Temperatures: C. H. Herty and W. S. Dickson.

A Rapid Method for the Determination of Oil in Cottonseed Products: C. H. Herty and M. Orr.

The Effect of Leaching Alcoholic Distillates through Wood Charcoal: Wm. L. Dudley.

The Mercerizing Process: J. M. Matthews.

Coal Modifications, Natural and Artificial: S. W. Parr.

Modifications of Illinois Coal by Low Temperature Distillation: S. W. Parr and C. K. Francis.

An Initial Coal Substance having a Constant Thermal Value: S. W. Parr and W. F. Wheeler.

Reactions in Water Softening: Edward Bartow.

The Relation between Teachers of Chemistry and the Chemical Industries: B. B. Freud.

Note on the Determination of Unsaponifiable Matter in Oils and Fats: A. G. Stillwell.

A Method for Preparing a Standard Alkaline Solution: David Wilbur Horn.

The Nature of the Volatile Matter of Coal as Evolved under Different Conditions: Horace C. Porter and F. K. Ovitz.

Refining and Testing Wood Turpentine: F. P. Veitch and M. G. Donk.

The Determination of Vanadium, Molybdenum, Chromium and Nickel in Steel: Andrew A. Blair.

Selective Economy in Raw Materials: H. F. Mork.

The Basis of Quality in Paper: A. D. Little.

The Calorific Power of Petroleum Oils and the Relation of Density to Calorific Power: H. C. Sherman and A. H. Kropff.

A Comparison of the Calculated and Determined Viscosity, Flash and Fire Tests in Oil Mixtures: H. C. Sherman, T. T. Gray and H. A. Hammerschlag.

Paint Analysis: Percy H. Walker.

A Microscopic Investigation of Broken Steel Rails: Henry Fay.

Industrial Chemistry as Taught at Pratt Institute: Allen Rogers.

B. E. Curry,
Secretary

(*To be continued*)